

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
18 September 2003 (18.09.2003)

PCT

(10) International Publication Number
WO 03/076854 A1

(51) International Patent Classification⁷: **F25B 9/00**

(21) International Application Number: **PCT/US03/06580**

(22) International Filing Date: **5 March 2003 (05.03.2003)**

(25) Filing Language: **English**

(26) Publication Language: **English**

(30) Priority Data:
60/361,651 **5 March 2002 (05.03.2002) US**

(71) Applicant (for all designated States except US): **SHI-APD CRYOGENICS, INC.** [US/US]; 1833 Vultee Street, Allentown, PA 18103-4783 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **GAO, Jin, Lin** [US/US]; c/o Shi-Apd Cryogenics, Inc., 1833 Vultee Street,

Allentown, PA 18103-4783 (US). **LONGSWORTH, Ralph, C.** [US/US]; Shi-Apd Cryogenics, Inc., 1833 Vultee Street, Allentown, PA 18103-4783 (US).

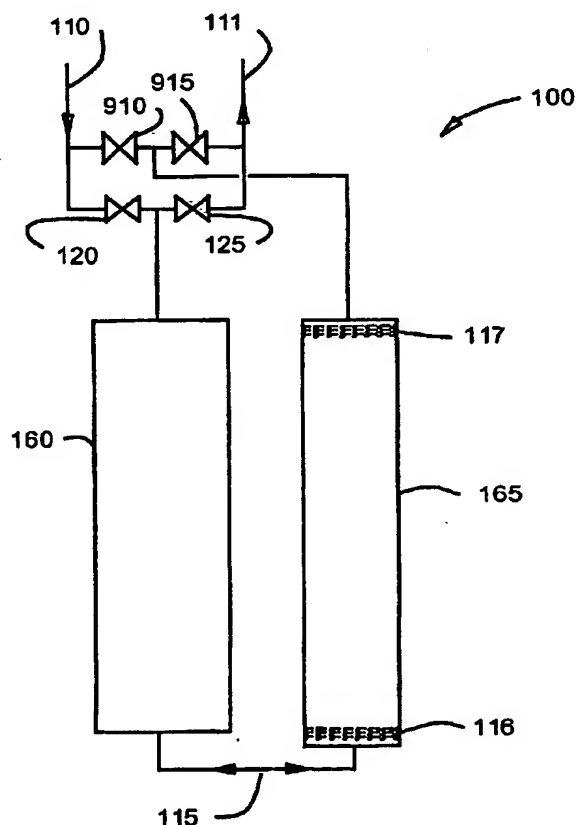
(74) Agents: **HELFGOTT, Samson et al.**; Katten Muchin Zavis Rosenman LLP, 575 Madison Avenue, New York, NY 10022-2585 (US).

(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),

[Continued on next page]

(54) Title: **FAST WARM UP PULSE TUBE**



(57) Abstract: This invention provides an improved means of quickly warming a pulse tube (165) by shifting the phase relation of flow to the warm end of the pulse tube relative to flow to the warm end (117) of the pulse tube relative to flow to the warm end of the regenerator (160) using a "four valve" concept and the "active buffer" concept. Several different pulse tube configurations and valve timing relations that are effective at reversing the cycle from the normal mode, which produces cooling at the pulse tube heat station, to a reverse mode that produces heating are disclosed.